- T.38 Real-time FAX over IP (G.723.1 and G.729A CODEC only.)—The edge server card can receive UDPL frames from the HiPer DSP, encapsulate them in a UDP datagram and send them to the destination edge server card. The edge server card can also receive a datagram from the LAN UDP that contain UDPTL frames and send them to the appropriate HiPer DSP.
- Auto-detection of Voice, FAX, Data—Depending upon which CODEC is configured for a call, the Gateway can automatically detect and set up voice, FAX, and data calls. For further detail, see Chapter 1 to the *Total Control 1000 Media Gateway Guide*.
- T1-PRI, E1-PRI, E1-R2, SS7 IMT Interworking - The Media Gateway supports connections between dissimilar Telco connections. This means that the ingress Gateway and the egress Gateway to which it communicates to complete a call do not need to have the same Telco interface for the call to be completed. For example; an ingress Gateway with T1-PRI lines connected to its HiPer DSPs can complete a VoIP call to an egress Gateway that has T1-PRI, E1-PRI or E1-R2 connections.

## H.323 Gatekeeper

The Gatekeeper runs on a stand-alone Windows NT 4.0 Server or Windows 2000 Server and provides centralized call control, call routing, and overall system command and control.

The Gatekeeper application runs as a Windows service that:

- Registers and deregisters Media Gateways
- Assists Media Gateways in call setup and teardown
- Manages access to Media Gateways, identifies Back-end Servers, collects operational statistics, and generates traps
- Balances loads when there are multiple egress Media Gateways
- Consults the Directory Mapping Server to provide ingress Media Gateways with egress IP addresses that map to dialed telephone numbers
- Assembles Call Detail Records (CDRs) and logs them to Accounting Servers

When the Gatekeeper service starts, it logs an event in the Windows Event Viewer; this generates an SNMP trap. The Gatekeeper also generates traps when it finds each message queue and when it is ready to register Media Gateways.

*When using the direct routed call model, the Gatekeeper is capable of supporting at least 250,000 Busy Hour Call Attempts (BHCA).*

In IP Telephony Manager, the Media Gateway can be configured to use the Gatekeeper Routed Model. This means that if there is a Gatekeeper crash, active calls are dropped. However, if two Media Gateways are registered with different Gatekeepers, and one Gatekeeper is using Routed Call signalling, the egress Gateway supports the reception of an Admission Reject (ARJ) with a cause code of routeCallToGatekeeper. The Media Gateway also supports sending a facility message to have the call rerouted through the Gatekeeper. With the Routed Model, both Q.931 and H.245 signalling are routed. The default is Direct Routed.

## SIP Proxy Server

In general, a proxy interprets, and if necessary, rewrites a request message before forwarding it. Within a Session Initiation Protocol (SIP) CommWorks IP Telephony System configuration, the SIP Proxy Server acts as both server and client for the purpose of making requests on behalf of other clients. Requests are serviced internally or passed on, possibly after translation, to other servers.

Specifically, the SIP proxy:

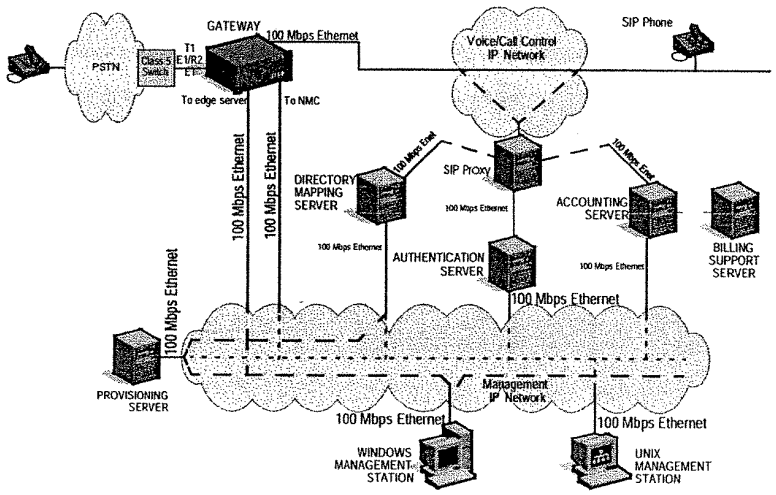
- Registers clients (SIP phones, SIP enabled Media Gateways, and other SIP devices).
- Manages call setup on- and off-net
- Looks to the subscriber database (Directory Mapping Server) for E.164 to IP address translation for both on-net and off-net calls

Major features of the CommWorks SIP Proxy Server include:

- RFC 2543 bis-02 compliance
- Sequential forking
- Call forwarding unavailable and call forwarding ring no answer support
- UDP and TCP request acceptance. Also registration on multicast.
- Proxy server, registration server, and redirect server support
- Transaction stateful and call stateful (proxy routed) call model support
- Legal loop detection, Via hiding, Expires timer, Max Forwards feature support
- Telnet support, via port 1822, to configure SIP proxy parameters.
- Support sending CDR's to the Accounting server directly when using SIP as the call control mechanism.

Figure 5 shows a typical CommWorks IP Telephony System configured for SIP.

**Figure 5** VoIP SIP System Diagram




The SIP Proxy Server can be configured for either state-full or stateless operation:

- State-full—The SIP Proxy Server holds information in regard to the set-up and tear-down of the call.
- Stateless—The SIP Proxy Server processes a message and forgets everything else in regard to the call, until the arrival of next message.

Refer to *CommWorks 4220 SIP Proxy Server Guide* for more information.

## Back-end Servers

This section describes the Back-end Servers.

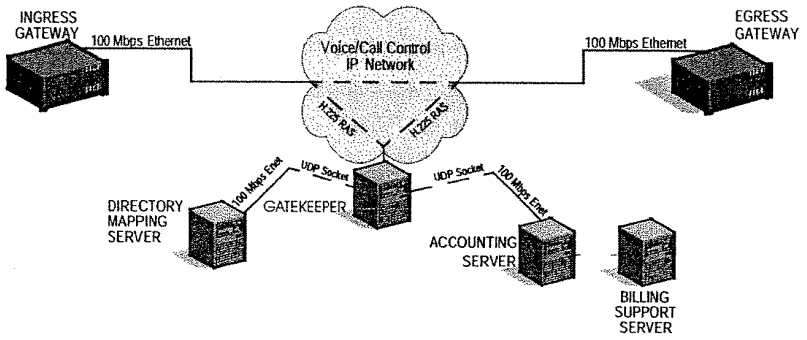
The Back-end Servers described are:

- Directory Mapping Server
- Provisioning Server
- Accounting Server
- Billing Support Server

### Directory Mapping Server

The Directory Mapping Server runs on a Windows NT 4.0 Server or a Windows 2000 Server with Microsoft SQL Server 7.0. The Gatekeeper and the SIP Proxy calls upon the Directory Mapping Server mapping database when it needs to know the IP address of a destination Media Gateway. The Directory Mapping Server responds with a prioritized list of destination Gateways that are available to complete the call. The Gatekeeper selects one of the Media Gateways based on port availability.

**Figure 6** Network Components




The Directory Mapping Server interfaces with the Gatekeeper using a proprietary User Datagram Protocol (UDP) sockets interface over IP. The Directory Mapping Server interfaces with the Provisioning Server using (SQL) over IP.

The Directory Mapping Server contains a database that maps destination telephone numbers (E.164 format) to a list of egress Gateways. When a Gatekeeper requests a list, the Directory Mapping Server responds with a prioritized list of egress Gateways that can complete the call. The Directory Mapping Server also does dialed number translation and format checking. It supports the North American Numbering Plan (NANP) and international numbering plans within selected countries.

**Provisioning Server**

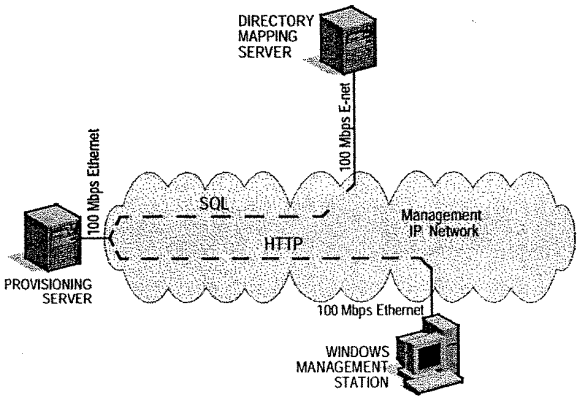
The Provisioning Server provides a means for network administrators to configure the Directory Mapping Server. Typical tasks that you can do from the Provisioning Server are assigning Media Gateways to Gatekeepers and assigning routes to Gatekeepers or SIP Proxy.

The Provisioning Server runs on a Windows NT 4.0 server or a Window 2000 Server and stands between the Directory Mapping Server, with which it communicates using SQL over IP, and a Windows PC running Microsoft Internet Explorer, with which it communicates using Dynamic HyperText Markup Language (DHTML) and JavaScript. For a Provisioning database, a Microsoft SQL Server must be on the network and available to the Web Provisioning Server.

Windows computers that run Internet Explorer contact the Provisioning Server by IP address. The Provisioning Server runs a web server application. Because the Provisioning Server uses ActiveX controls, Administrative clients must run Microsoft Internet Explorer on a Windows PC.

You can assign user names and passwords to protect the Provisioning Server from unauthorized use.

**Figure 7** Provisioning Server in the VoIP Network




**Accounting Server**

The Accounting Server runs on a Windows NT Server or a Window 2000 Server with Microsoft SQL Server 7.0 or Windows 2000 server. The SIP Proxy or Gatekeeper sends Call Detail Records (CDRs), which are initiated by the Media Gateways, to the Accounting Server message queue. (In a SIP setup, the Gatekeeper is replaced with a proxy server. The Media Gateway, therefore, communicates directly with the Accounting Server.) The message queue stores CDRs until the database is ready to accept them. The message queue then passes the data to an SQL database.

Each successfully completed call results in four CDRs: ingress start, ingress end, egress start, and egress end. CDRs can be used for billing, service-level analysis, monitoring, and trouble locating and clearing.

### Call Detail Records

During a normal call, four CDRs are logged into the table in the database on the Accounting Server. One CDR is logged at call initiation and one at call termination from each of the ingress and egress Gateways.

The Billing Support Server combines the four CDRs into a single super CDR for use by an external billing system.

**Super Call Detail Records**

The Super CDR merges all the CDRs that belong to a call. The four CDRs generated in a call are:

- Ingress call open
- Egress call open
- Ingress call close
- Egress call close

The Super CDR is stored in a new database that is created on the Billing Support Server. The CDR data is transferred into the new database by a Data Transformation Service (DTS) procedure.

**Billing Support Server**

The Billing Support Server is a specialized Accounting Server that is dedicated to extracting CDRs from the primary Accounting Server. The Billing Support Server then processes the CDRs into Super CDRs (the four CDRs that are generated for each call become one). Super CDRs are available to the proprietary accounting and billing systems of telephone companies, or to a third party accounting and billing system.

## SNMP Management Subsystem

SNMP provides the primary means of configuring, upgrading, and gathering operational data from the components of the CommWorks IP Telephony platform.

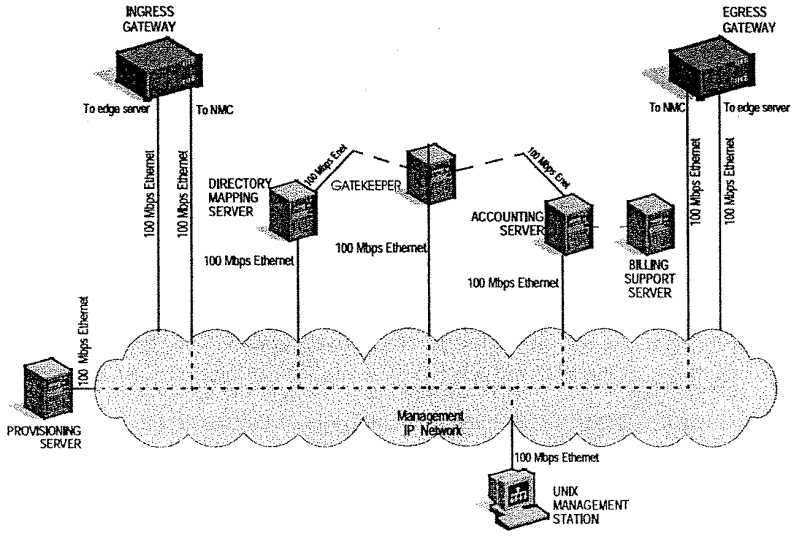
The IP Telephony Manager is the CommWorks SNMP element management application; it can manage the following CommWorks components:

- Gatekeeper
- Directory Mapping Server
- Billing Support Server
- Accounting Server
- Provisioning Server
- Media Gateways
- SIP Proxy
- HiPer DSP
- HiPer NMC

*The Network Management Card acts as a proxy agent for the rest of the cards and systems within the Media Gateway, including the edge server cards.*

You can use a third-party SNMP application to monitor the network status and to monitor alarm services. Either IP Telephony Manager integrated with HP OpenView on the HP-UX and Sun Solaris platform or CommWorks 5000 Network and Service Management system can be used to provide these features. You can also use the CommWorks 5000 Network and Service management system for this purpose.

**Figure 8** SNMP Management Subsystem

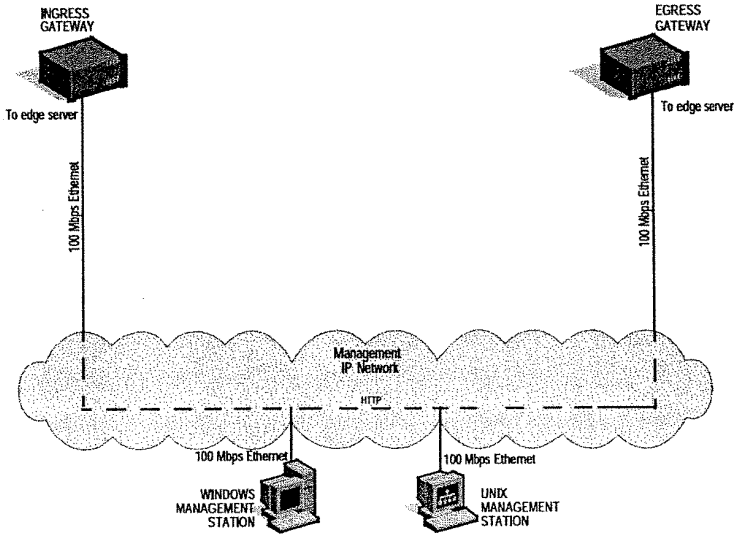



## Real-time Media Gateway Operating Statistics

The edge server cards in the Media Gateways run a web server that provides operating statistics and Windows event log messages in real time. You can use the Web server without disrupting call processing.

You access the web server by using the IP address of the edge server card and any web browser that is on the same IP network as the edge server card.

**Figure 9** Media Gateway Web Access




**Management Workstations**

Some management applications run on UNIX (HP-UX or Sun Solaris) workstations and some run on Windows.

**Windows Management Workstation**

You use the Windows management workstation to access all Windows NT components in the system. To manage the entire system from one workstation, you can install an X-Windows client, such as Hummingbird Exceed and then run applications from the UNIX management workstation.

You use Internet Explorer to access the Provisioning Server from which you can configure the Back-end Servers; you also use Internet Explorer to access the web interface on the ESPs from which you can view statistics and Windows NT event log messages.

**UNIX Management Workstation**

You can use HP OpenView or CommWorks 5000 (on Solaris) to monitor the status of all elements in the system and to act as an alarm server.

You use IP Telephony Manager to configure and monitor the components of the CommWorks system that do not use a Windows NT or Windows 2000 operating system, including configuring operational parameters, upgrading software and doing configuration backup and restore.

**Table 7** Management Software

| Software Package | Operating System | Function |
|---|---|---|
| Network management application, such as HP OpenView or CommWorks 5000 | ■ HP-UX<br>■ Sun Solaris | General network monitoring and alarm services |
| IP Telephony Manager | ■ HP-UX<br>■ Sun Solaris | SNMP management and software upgrades of all CommWorks components of the CommWorks IP Telephony platform |
| Internet Explorer | Windows | Configuration of Directory Mapping Server, when used to access the Provisioning Server |
| Any web browser | Any | Gathering statistics from edge server, viewing Windows NT event log messages |

## Other Features

This section describes other features of the CommWorks IP Telephony Platform.

### International Dialing Support

The CommWorks IP Telephony platform supports international dialing based on the E.164 standard. You configure and store country information in the edge server card. For more information, see the *Total Control 1000 Media Gateway Guide*.

### T.38 Real-time Fax Over IP

The CommWorks IP Telephony platform supports real-time fax over IP. The Media Gateway card in the Total Control Hub (TCH) can receive UDPTL frames from the HDM, encapsulate them in a UDP datagram, and send them to the destination Media Gateway card. The Media Gateway can also receive datagrams from the LAN UDP that contain UDPTL frames and send them to the appropriate HDM.

### Distributed Directory Mapping Server

The Gatekeeper supports a Distributed Directory Mapping Server feature. This means that when there are multiple Directory Mapping Servers in the network, if the Directory Mapping Server returns only the IP address of the egress Gatekeeper, the ingress Gatekeeper can still set up a call.

### Real-time Billing

The CommWorks IP Telephony platform supports real-time billing. When a call is completed, the system can pass the CDR to a third party billing system through the billing support server for updates to the account.

### Call Progress and Tone Generation

The system supports multiple and configurable call progress tones to the user including dial, busy, ring-back and congestion tones.

# 2 CALL FLOW

This chapter contains call flow information for standard call setup and normal call disconnect.

The types of call flows discussed are as follows:

- H.323/PRI Call Flow
- H.323/SS7 Call Flow
- SIP/PRI Call Flow
- SIP to SIP Call Flow
- SS7 and SIP Proxy Call Flow

## H.323 Call-Control Signaling Path

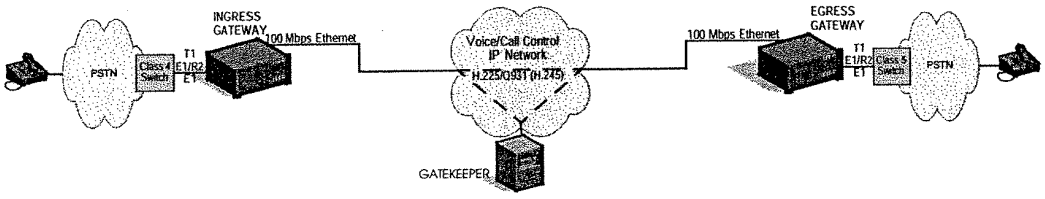
The Gateway converts Call Control messages from the T1 or E1 line to H.225; H.225 is a transport layer IP protocol for call control. First the HiPer Digital Signaling Processor (DSP) card converts messages into the internal packet bus protocol; then the Gateway converts the messages from the packet bus protocol to H.225.

The Gateways use the H.225 FastStart connection method; this reduces the effort of setting up an H.245 logical channel. If the Gateways reject FastStart, they use standard H.245 logical channel setup.

The Gateways and the Gatekeeper exchange H.225 Registration, Admission, and Status (RAS) messages.

Figure 10 shows the relationship between Q.931 Call Control Messaging and the H.225.0 v2 packet-based call signalling protocol.

**Figure 10** Call-Control Signalling Path



## H.323/PRI Call Flow

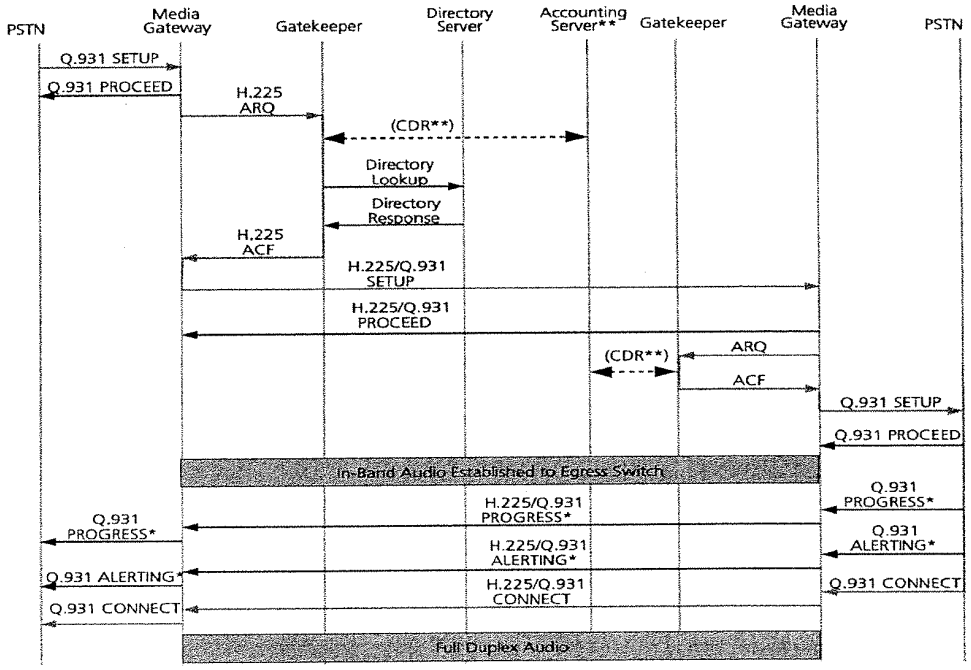
After setup between the PSTN and the ingress Media Gateway is complete, and after the ingress Media Gateway has registered with the Gatekeeper, the ingress Media Gateway sends an admission request containing the dialed number to the Gatekeeper. The Gatekeeper passes this request on to the Directory Mapping Server and logs a CDR to the Accounting Server, indicating that a call attempt is being made.

If the Directory Mapping Server sends back a lookup confirmation message containing egress Media Gateway addresses, the Gatekeeper passes the addresses on to the Media Gateway with an admission confirmation message. The ingress Media Gateway then sends a setup message to the egress Media Gateway, which responds to the ingress Media Gateway with a Proceed message.

When the egress Media Gateway sends the receiving Gatekeeper an admission request message, the receiving Gatekeeper responds with an admission confirmation if the receiving Gatekeeper and Media Gateway successfully register.

Finally, the receiving Media Gateway passes progress, alerting, and connect messages from the receiving PSTN to the ingress Media Gateway, the ingress Media Gateway passes these messages to the initiating PSTN, and full duplex audio is enabled.

**Figure 11** VoIP Successful Call Setup With Direct Routed Call Model




* Optional message.

** Accounting Server is optional when the Gatekeeper is configured not to pass CDR from GW to Accounting Server.

*Figure 11 assumes a Q.931 interface from each PSTN.*

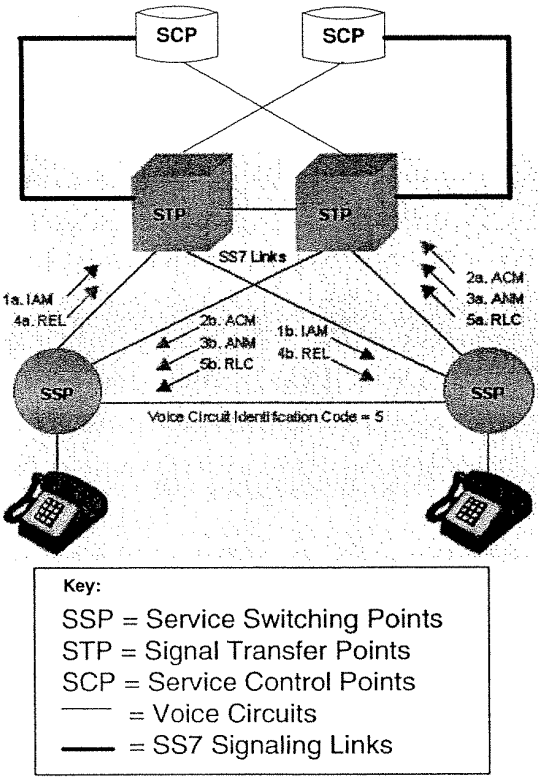
## H.323/SS7 Call Flow

This topic discusses a basic H.323 and SS7 call control. Figure 12 illustrates the SS7 signaling associated with a basic call.

1 When a call is placed to an out-of-switch number, the originating Signal Switching Point (SSP) transmits an ISUP initial address message (IAM) to reserve an idle trunk circuit from the originating switch to the destination switch (1a). The IAM includes the originating point code, destination point code, circuit identification code (circuit "5" in Figure 12), dialed digits and, optionally, the calling party number and name. The SCP accepts queries for enhanced services from the SSP and returns the requested information to the originator of the query.

   In the example below, the IAM is routed via the home STP of the originating switch to the destination switch (1b). Note that the same signaling link(s) are used for the duration of the call unless a link failure condition forces a switch to use an alternate signaling link.

**Figure 12** Basic SS7 Signaling




2 The destination switch examines the dialed number, determines that it serves the called party, and that the line is available for ringing. The destination switch rings the called party line and transmits an ISUP address complete message (ACM) to the originating switch (2a) (via its home STP) to indicate that the remote end of the trunk circuit has been reserved. The STP routes the ACM to the originating switch (2b) which rings the calling party's line and connects it to the trunk to complete the voice circuit from the calling party to the called party.

In the example shown above, the originating and destination switches are directly connected with trunks. If the originating and destination switches are not directly connected with trunks, the originating switch transmits an IAM to reserve a trunk circuit to an intermediate switch. The intermediate switch sends an ACM to acknowledge the circuit reservation request and then transmits an IAM to reserve a trunk circuit to another switch. This processes continues until all trunks required to complete the voice circuit from the originating switch to the destination switch are reserved.

3 When the called party picks up the phone, the destination switch terminates the ringing tone and transmits an ISUP answer message (ANM) to the originating switch via its home STP (3a). The STP routes the ANM to the originating switch (3b) which verifies that the calling party's line is connected to the reserved trunk and, if so, initiates billing.

4 If the calling party hangs-up first, the originating switch sends an ISUP release message (REL) to release the trunk circuit between the switches (4a). The STP routes the REL to the destination switch (4b). If the called party hangs up first, or if the line is busy, the destination switch sends an REL to the originating switch indicating the release cause (e.g., normal release or busy).

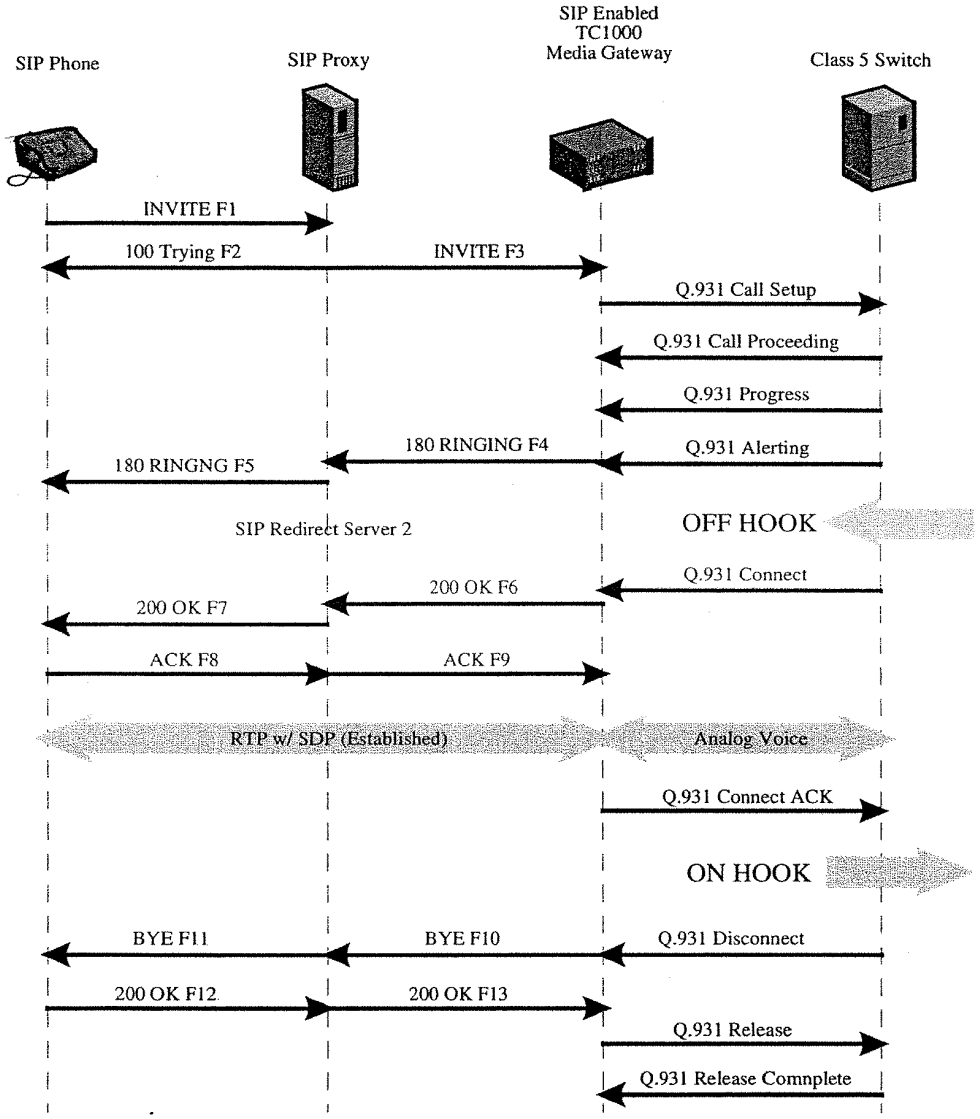
5 Upon receiving the REL, the destination switch disconnects the trunk from the called party's line, sets the trunk state to idle, and transmits an ISUP release complete message (RLC) to the originating switch (5a) to acknowledge the release of the remote end of the trunk circuit. When the originating switch receives (or generates) the RLC (5b), it terminates the billing cycle and sets the trunk state to idle in preparation for the next call.

ISUP messages may also be transmitted during the connection phase of the call (i.e., between the ISUP Answer (ANM) and Release (REL) messages.

## SIP/PRI Call Flow

When a SIP device initiates a call to a destination that is not a SIP device, call flow progresses as shown in Figure 13.

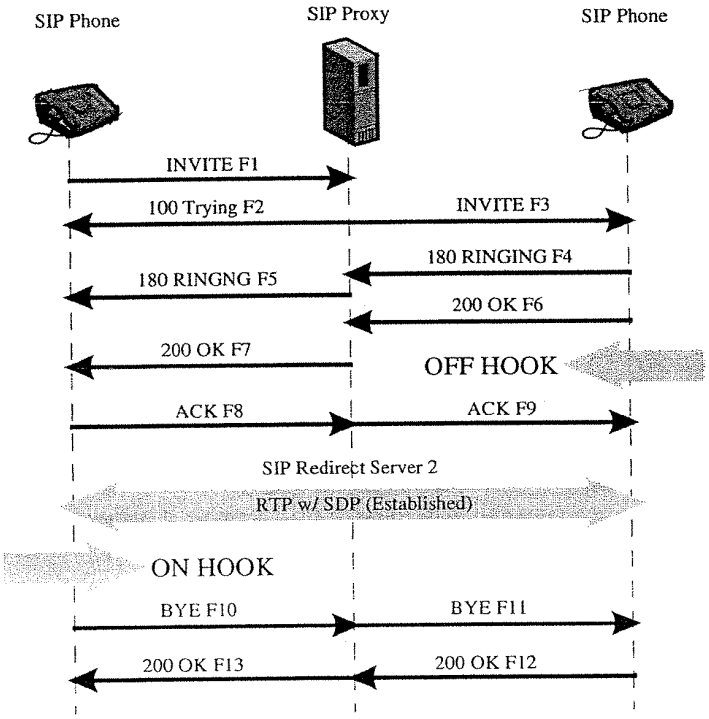
**Figure 13** SIP-to-PSTN Call Flow



## SIP to SIP Call Flow

When a SIP device initiates a call to another SIP device, call flow progresses as shown in Figure 14.

**Figure 14** SIP-to-SIP Call Flow



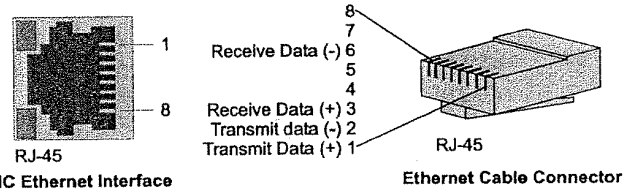
**Cable Type** HiPer NMC ethernet NICs accept cabling that meets the following specifications:

**Table 10** HiPer NMC Cabling Specifications

| | |
|---|---|
| Data transfer rate | 10/100 Mbps Auto-negotiated |
| Access scheme | CSMA/CD (Carrier Sense Multiple Access with Collision Detection) |
| Transmission medium | Unshielded Twisted Pair (UTP) cable type CAT3 or CAT5 (CAT5 recommended) for 10Base-T applications, CAT5 for 100Base-TX |
| Maximum lobe distance | 100 m (328 ft) |
| Connector | 8-position modular jack, Stewart 88-360808 or equivalent |
| Wire type | 0.5 mm or 24 AWG twisted pairs |
| Maximum cable length | 100 m (328 ft) with standard receiver squelch levels |
| Loss | 11.5 dB per100 m for frequency range of 5–10 MHz |
| Impedance | 85-111 ohm for frequency range of 5-10 MHz |
| Propagation delay | 5.7 ns/m |
| Cabling | Use a straight-through cable for multiport repeater applications<br>(If two-node network: use a crossover cable) |
| Nominal direct current resistance | Center conductor<br>24 AWG (7 strands 32 AWG); 0.61 mm diameter<br>77.8 ohm/km(23.7 ohm/1000 ft)<br>Shield<br>50.9 ohm/km(15.5 ohm/1000 ft) |
| Outside diameter | 6.73 mm(0.265 in.) |
| Capacitance between conductors | 98 picofarad/m(30 picofarad/ft) |

### Edge Server Card

Edge server ethernet interfaces have the following pinouts:



**Cable Type** Edge server ethernet NICs accept cabling that meets the following specifications:

**Table 11** Edge Server Cabling Specifications

| | |
|---|---|
| Data transfer rate | 10/100 Mbps Auto-negotiated |
| Access scheme | CSMA/CD (Carrier Sense Multiple Access with Collision Detection) |
| Transmission medium | Unshielded Twisted Pair (UTP) cable type CAT3 or CAT5 (CAT5 recommended) for 10Base-T applications, CAT5 for 100Base-TX |
| Maximum lobe distance | 100 m (328 ft) |
| Connector | 8-position modular jack, Stewart 88-360808 or equivalent |
| Wire type | 0.5mm or 24 AWG twisted pairs |
| Maximum cable length | 100 m (328 ft) with standard receiver squelch levels |
| Loss | 11.5 dB per100 m for frequency range of 5–10 MHz |
| Impedance | 85-111 ohm for frequency range of 5-10 MHz |
| Propagation delay | 5.7 ns/m |
| Cabling | Use a straight-through cable for multiport repeater applications<br>(If two-node network: use a crossover cable) |
| Nominal direct current resistance | Center conductor<br>24 AWG (7 strands 32 AWG); 0.61 mm diameter<br>77.8 ohm/km(23.7 ohm/1000 ft)<br>Shield<br>50.9 ohm/km(15.5 ohm/1000 ft) |
| Outside diameter | 6.73 mm(0.265 in.) |
| Capacitance between conductors | 98 picofarad/m(30 picofarad/ft) |

# 4 TECHNICAL SPECIFICATIONS

This chapter contains technical specifications for the CommWorks IP Telephony Platform and for the Total Control components.

This chapter contains technical specifications for the following components:



## Regulatory Compliance

This section describes US and Canadian regulatory compliance.

### Compliance Statement

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

### Industry Canada Canadian Installations

The Industry Canada (IC), formerly Canadian Department of Communications, label identifies certified equipment. Certification means that equipment meets certain telecommunications network protective, operational, and safety requirements. The department does not guarantee the equipment will operate to the purchaser's satisfaction.

Before installing this equipment, be sure a connection to a local telecommunications company is permissible. Install equipment using an acceptable method. Be aware, however, that compliance with these conditions may not prevent degradation of service in some situations.

Repairs to certified equipment should be made by an authorized Canadian maintenance facility designated by the supplier. Any repairs or alterations made by a user to this equipment, or equipment malfunctions, may give the telecommunications company cause to request the user to disconnect the equipment. For protection, be sure that electrical ground connections of the power utility, telephone lines, and internal metallic water pipe system, if present, are connected together. This precaution may be particularly important in rural areas.

***Caution:*** *Do not attempt to make such connections; contact the appropriate electrical inspection authority or electrician.*

*Certifications for individual devices are listed under the specifications for each device.*

### CommWorks System Specifications

The following table contains system-level specifications for the CommWorks Gateway.

**Table 12** System Specifications

| Specifications | Description | | |
|---|---|---|---|
| Supported CODECs | G.711: | 64 Kbps | 20 ms |
| | G.723.1: | 6.3 Kbps | 30 ms |
| | G.729A | 7 Kbps | 10 ms |
| Compression | RTP/UDP/IP header compression (Van Jacobson) | | |
| Capacity | (see Chapter 1) | | |
| Echo Cancellation | G.168 compliant | | |
| Jitter Compensation | Jitter buffer size: 0–240 ms | | |

# Total Control Specifications

## Chassis Specifications

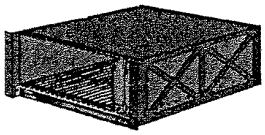


**Table 13** Chassis Specifications

| Specifications | Description |
|---|---|
| Certification | Complies with FCC Part 15 Class A, FCC Part 68, UL-listed, CSA-approved, and IC-certified. |
| | This product complies with the European EMC directive and bears the "CE" mark. |
| Capacity | Houses up to 17 front-loaded application cards (NACs), and their respective rear-loaded interface cards (NICs); |
| | Two Power Supply Unit/Power Supply Interface combinations (PSU/PSIs); the second optional for full redundancy; and, |
| | One fan tray assembly. |
| Midplane Data Buses | |
| | Packet bus: |
| | NAC management bus: |
| | NIC management bus: |
| | TDM bus (NAC - NAC): |
| | TDM bus (NIC - NAC): |
| | PCI bus (NIC - NAC): |
| | ISA bus (NIC - NAC): |
| Environment | Shipping and storage |
| | Temperature:-25–75° C (-13–167° F) |
| | Relative humidity:0–95% (non-condensing) |
| | Operating |
| | Temperature:0–40° C (32–104° F) |
| | Relative humidity:0–95% (non-condensing) |
| Dimensions | Length:47.22 cm(18.59 in.) |
| | Width:48.26 cm(19.00 in.) |
| | Height:22.15 cm(8.71 in.) |

## 130A Power Supply Specifications

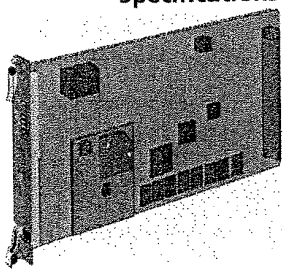


**Table 14** 130A Power Supply Specifications

| Specifications | Description |
|---|---|
| Certification | Complies with FCC Part 15 Class A, FCC Part 68, UL-listed, CSA-approved, and IC-certified.<br>This product complies with the European EMC directive and bears the "CE" mark. |
| Power Supply | Auto-shutoff for overvoltage, over temperature, and short-circuit protection<br>Automatic load sharing and redundant switchover when two PSUs are installed. Requires a separate power source for each PSU. |
| Power Requirements | Specified range:<br>AC PSUAC input voltage range: 90 to 264 V AC @ 47-63 Hz<br>DC PSUDC input voltage range: -40 to -60 V DC |
| Maximum PSU Output Power | 280 watts<br>+5.2VDC130.0 A<br>-5VDC2.0 A<br>+12.2VDC5.5 A<br>-12.2VDC5.5 A |
| Power Supply Input | Typical input power<br>DC to DCAC to AC<br>130 A PSU1095 watts1080 watts<br>Maximum input current*<br>DC to DCAC to AC<br>130 A PSU30 A15 A<br>* Steady state, full load input current is rated at 25A. |
| Environment | Shipping and storage<br>Temperature:-40–60° C (-40–140° F)<br>Relative humidity:10–95% (non-condensing)<br>Operating<br>Temperature:0–40° C (32–104° F)<br>Relative humidity:20–80% (non-condensing) |
| Dimensions | Length:32.89 cm(12.95 in.)<br>Width:1.98 cm(0.78 in.)<br>Height:17.48 cm(6.88 in.) |

## Fan Tray Specifications

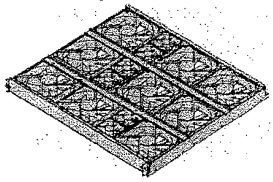


**Table 15** Fan Tray Specifications

| Specifications | Description |
|---|---|
| Certification | Complies with FCC Part 15 Class A, FCC Part 68, UL-listed, CSA-approved, and IC-certified.<br>This product complies with the European EMC directive and bears the "CE" mark. |
| Air Flow (Total) | 948 CFM |
| Current Draw | 5.2 VDC @ 3.6A typical maximum*<br>* "Typical maximum" refers to the maximum current draw for most typical configurations. |
| Environment | Shipping and storage<br>Temperature:-40° C to 70° C at 65% relative humidity<br>Operating<br>Temperature:-40° C to 70° C at 65% relative humidity |
| Dimensions | Length:47.22 cm(18.59 in.)<br>Width:48.26 cm(19.00 in.)<br>Height:4.27 cm(1.68 in.) |

***CAUTION:*** *Total Control chassis must be installed with a minimum of 1.7 in. clearance between each unit.*

## HiPer Network Management Card (NMC) NAC Specifications

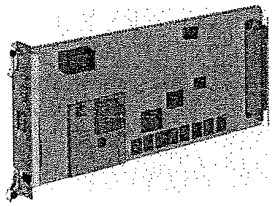


**Table 16** HiPer NMC NAC Specifications

| Specifications | Description |
|---|---|
| Certification | Complies with FCC Part 15 Class A, FCC Part 68, UL-listed, CSA-approved, and IC-certified. |
| | EN 55022, Class A |
| | EN 50082 |
| Processor | Pentium processor (P5) at 133 MHz |
| Operational Memory | Dynamic Random Access Memory (DRAM): 16 Mbytes |
| | Flash Memory: 8 MB |
| Data Retention method | Clock and CMOS retained by 3V lithium (coin) cell |
| | Retention: up to 10 years (powered unit), 3 years in non-powered unit |
| Current Draw | +5.2 VDC @ 4.3A typical maximum* |
| | * "Typical maximum" refers to the maximum current draw for most typical configurations. |
| Environment | Shipping and storage |
| | Temperature:-25–75° C (-13–167° F) |
| | Relative humidity:0–100% (non-condensing) |
| | Operating |
| | Temperature:0–40° C (32–104° F) |
| | Relative humidity:0–95% (non-condensing) |
| Dimensions | Length:32.89 cm(12.95 in.) |
| | Width:2.01 cm(.79 in.) |
| | Height:17.53 cm(6.90 in.) |

## 10/100 Ethernet Aux I/O NIC (for HiPer NMC) Specifications

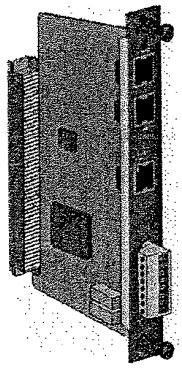


**Table 17** 10/100 Ethernet Aux I/O NIC Specifications

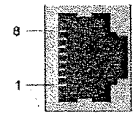
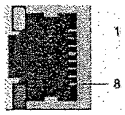
| Specifications | Description | | |
|---|---|---|---|
| Certification | Complies with FCC Part 15 Class A, FCC Part 68, UL-listed, CSA-approved, and IC-certified.<br>EN 55022, Class A<br>EN 50082 | | |
| Interface Specifications | | | |
| | Serial Port (applies to both EIA-232 and WAN) | | |
| | | Electrical: | EIA RS–232–D standard |
| | | Connector: | RJ–45, 8-position modular jack |
| | | Pinout:   | 1 = DSR<br>2 = DCD<br>3 = DTR<br>4 = Ground<br>5 = Receive data<br>6 = Transmit data<br>7 = CTS<br>8 = RTS |
| | | Configuration: | DTE |
| | | Transmission method: | Unbalanced RS–232, 1-stop bit, no parity |
| | | Transmission rate: | 57.6 Kbps maximum |
| | Ethernet 10Base-T/100Base-Tx | | |
| | | Data transfer rate: | 10/100 Mbps (auto-negotiated) |
| | | Connector: | 8-position modular jack (Stewart 88-360808 or equivalent) |
| | | Pinout:   | 1 = Transmit +<br>2 = Transmit -<br>3 = Receive +<br>4 = Ground<br>5 = Ground<br>6 = Receive -<br>7 = Ground<br>8 = Ground |
| | | Accessing scheme: | CSMA/CD (Carrier Sense Multiple Access with Collision Detection) |
| | | Topology: | Star-wired hub (using multiport repeater) |
| | | Maximum nodes: | Limited only by repeater used |
| | | Transmission medium: | Unshielded twisted pair (UTP)<br>**10Base-T:** CAT3 or CAT5 (CAT5 recommended)<br>**100Base-Tx:** CAT5 only |
| | | Network lobe distance: | 100 m (328 ft.) suggested maximum. Longer cabling can be used at the expense of reduced receiver squelch levels. |

**Table 17** 10/100 Ethernet Aux I/O NIC Specifications (continued)

| Specifications | Description |
|---|---|
| Current Draw | +5.2 VDC @ 0.6A typical maximum* |
| | * "Typical maximum" refers to the maximum current draw for most typical configurations. |
| Environment | Shipping and storage |
| | Temperature:-25–75° C (-13–167° F) |
| | Relative humidity:0–100% (non-condensing) |
| | Operating |
| | Temperature:0–40° C (32–104° F) |
| | Relative humidity:0–95% (non-condensing) |
| Dimensions | Length:12.07 cm(4.75 in.) |
| | Width:2.01 cm(.79 in.) |
| | Height:17.53 cm(6.90 in.) |